

**ABSTRACT:****CAVITY RING-DOWN SENSING APPARATUS AND METHODS**

This invention is generally concerned with apparatus and methods for sensing based upon evanescent-wave cavity ring-down spectroscopy (CRDS), in particular time-resolved and multiplexed sensing techniques.

We describe an evanescent wave cavity-based optical sensor, the sensor comprising: an optical cavity formed by a pair of highly reflective surfaces such that light within said cavity makes a plurality of passes between said surfaces, an optical path between said surfaces including a reflection from a totally internally reflecting (TIR) surface, said reflection from said TIR surface generating an evanescent wave to provide a sensing function; a light source to inject a pulse of light into said cavity; a detector to detect decaying oscillations of said light pulse within said cavity; and a signal processor coupled to said detector and configured to provide a time-resolved output responsive to a light level within said cavity and having a time-resolution corresponding to a set of said light pulse oscillations, whereby said sensing function operates at substantially said time-resolution. We further describe a system where one or more TIR surfaces are provided with at least two functionalising materials responsive at different wavelengths such that an interaction between a said functionalising material and one or more targets to be sensed is detectable as a change in absorption of a said evanescent wave at a said wavelength.

Figure 16